TRANSMITTAL SLIP	DATE 12 Nov 82	
TO: NIO/E		
ROOM NO. 7E48	BUILDING Hqs.	
REMARKS: FYI		
FROM: Harry Rowen, C/NIC		
ROOM NO.	BUILDING	EXTENSION

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THE DIRECTOR OF
CENTRAL INTELLIGENCE

National Intelligence Council

10 November 82

[redacted]

NOTE FOR: NIO/LA

Thanks for sending me the piece by Thomas Gold. I'm familiar with his thesis that has been much publicized in recent years. It hardly needs saying that it is very controversial in scientific circles. In fact, I believe that he has few supporters. This is not to suggest that he is wrong, though; he is a person of great talent.

He is quite right in suggesting the potential economic and political importance of the existence of large quantities of deep gas, if indeed he is right. I will try and see if there's some way of getting an updated reading on the state of controversy concerning his thesis and if it seems worth it, figure out some way of persuing this subject.

Harry

Harry Rowen

[redacted]

[redacted]

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THE DIRECTOR OF
CENTRAL INTELLIGENCE

National Intelligence Council

10 November 1982

[redacted]

NOTE FOR: Chairman, NIC

FROM: Constantine C. Menges
NIO/LA

Harry,

David Bardin is a friend and former senior Carter administrative official in the Department of Energy.

What is your reaction to the attached discussion of deep natural gas? Should the issue be pursued analytically somewhere in the US Government?

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Constantine C. Menges

Attachment:
as stated

[redacted]

[redacted]

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David J. Bardin
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August 2, 1982

Dr. Constantine Menges
National Intelligence Officer
for Latin America
Central Intelligence Agency
Washington, D. C. 20505

Dear Constantine:

Enclosed is the most recent statement by Professor Thomas Gold of Cornell regarding deep natural gas. Fortuitously, it arrived today. I think it gives you a reasonably good overview. If one were particularly interested in Latin America, there are a number of potential deep gas targets. In Brazil, for example, the Amazon Basin offers one opportunity. Nearer to the industrial market, I understand there is also a potentially interesting basin north of Sao Paulo.

It turns out that Brazil is making methanol out of sugarcane. Critics of the program include those who complain about converting the poor man's food into the rich man's fuel. If Brazil found enough natural gas, it could ultimately convert that gas (which is methane) into methanol, the alcohol fuel that vehicles in Brazil are being designed to use.

I would hope that a key group of U. S. Government thinkers concerned about the economic and political future of the World might invite Professor Gold to visit with them and consult with them from time to time. As I have mentioned to you, the potential abundance of deep natural gas, if proven in a number of continental and island sites, could profoundly affect strategic energy thinking. Once information was available about the existence of deep gas resources in disbursed locations, near consumption centers, market forces could be relied upon to develop such resources on a timely basis. Lacking such preliminary information, however, we easily stumble into the conclusion that resources already discovered in remote places (such as Siberia or the Persian Gulf) are indispensable in our lifetime.

Let me know your reactions.

Faithfully,

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Enclosure

Testimony by Professor Thomas Gold
before the
Committee on Science and Technology
Subcommittee on Energy Development and Applications
U.S. House of Representatives

July 30, 1982
Roswell, New Mexico

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Mr. Chairman, members of the Subcommittee:

I see the subject from the perspective not of a genuine global shortage of energy sources, but of a shortage which is purely man-made and therefore can be removed completely by appropriate action.

I and my group at Cornell have worked for five years now on the subject of natural gas, its origin and the chemical and biological processes through which it is related to other hydrocarbon deposits. This work brings us to the conclusion that natural gas is enormously more prevalent than has hitherto been thought. In particular the deeper range of the accessible levels, from 15,000 to 30,000 ft depth, is likely to contain reserves that are very much greater than all known shallower reserves of oil and gas. This holds for the territory of the U.S., but also for a large fraction of the rest of the world. If this is correct then the policy that can make the U.S. independent of imported oil is a policy that encourages an exploration and drilling program to these depths. I will return to this point later, but first I should make clear what the scientific reasoning is on which we base our optimistic outlook concerning gas.

In recent years one has come to understand a great deal more about the construction of the solar system, in part through the space science programs of NASA, in part through meteorite research, and in part through general advances in physics and chemistry. Through this one gains new insight into the construction of the planets, including the Earth.

The element carbon, the fourth most abundant in the solar system, is very prominent among the major planets and their satellites, among the comets and the asteroids and also among the meteorites that fall on the Earth. The greatest quantity is, of course, in the major planets and there it seems to be mostly in the form of methane gas (CH_4) while it is in the form of solid hydrocarbons and other unoxidized carbon compounds in the carbon-rich meteorites called carbonaceous chondrites. In the chemical evolution of the solar system, most of the carbon was turned into hydrocarbons.

The rocks that compose the bulk of the Earth have only very little carbon in them, yet the surface and the sediments contain much carbon, and it is clear that there was a large extra supply, not just the weathering of the rocks that made up the sediments. Like the water of the oceans and the nitrogen of the atmosphere, carbon must have been supplied from ~~buried~~ materials and migrated to the surface as a gas. Substantial accumulations of materials like that of the carbonaceous chondrites appear to have been included in the forming earth and later, under the action of heat and pressure, they have evolved gases that escaped to the surface. Carbon, in that case, would be expected to be predominantly in the form of methane at the outset.

That an outgassing process of the Earth from some particular layers or pockets underneath must be responsible for most of the volatile substances on the surface, has been appreciated for some time. It used to be thought however, that the carbon was supplied entirely in the form of carbon dioxide (CO_2) and that, in any case, methane, the other possible carbon gas, would not be stable at depth. The new realization is that methane is a much more likely source of the carbon and one has clear evidence that methane does exist at depths of more than 100 kilometers (60 miles). It has also become clear that methane will be stable on some of the pathways leading to the surface. These realizations have come about as a result of a better understanding of the chemical circumstances in the deeper layers of the crust of the Earth, a study of the processes by which gases can make their way to the surface and the recognition of many clear indications of a deep origin of natural gas deposits. In some circumstances the methane will be burnt on the way up and the resulting CO_2 that is created has been responsible in the past for the opinion that CO_2 was the only carbon gas emitted from the deep Earth.

The situation is well summed up in the recent report of the Gas Research Institute (GRI 1981 Annual Report), from where we take the following quote:

> <u>Theory of non-biological origin of natural gas stimulates increasing interest and acceptance.</u> Present gas exploration practices assume that natural gas and other hydrocarbon deposits were produced solely by the decomposition of plant and animal remains from previous eras. This assumption is now under strong challenge by a theory in which the role of organic materials may be only supplementary to preexisting methane of non-biological,

or abiogenic, origin. Broader acceptance of the theory, resulting from a growth of supporting evidence, could lead to radical changes in deep gas exploration strategies and subject to proof of economic viability, the discovery of a much larger resource base than is now thought to exist.

Being explored by Professor Thomas Gold of Cornell University with GRI support, the theory of abiogenic methane combines the findings of research in astrophysics with evidence from several natural phenomena on Earth. The theory postulates that vast quantities of hydrocarbon gases existing at the earliest stages of the Earth's history became trapped deep below the planet's surface. Slowly migrating upward over eons of time, some abiogenic gas may have reached reservoirs with impermeable caps; some combined with oxygen, escaped through volcanoes as carbon dioxide, and combined with calcium in the oceans to form carbonate rocks; some interacted with organic hydrocarbon deposits, enlarging and enriching them; and some escaped through deep faults directly into the oceans and atmosphere as free or dissolved methane.

A number of scientific observations forms a growing body of evidence in support of the abiogenic methane theory.

High success rates in deep drilling for natural gas have been noted in several areas, and indeed a very widespread presence of gas at the deeper levels has been noted, as could be expected on the basis of the theory outlined above, but was not expected on the basis of a purely biogenic origin. Some of the drillers are convinced now that the quantities of gas that they have found could not be explained otherwise. Others, who still side with the biogenic theory of the origin of the gas, believe then that the circumstances for the deposition of the source material at great depth must have been very much more favorable than had previously been thought. In any case there is very widespread agreement among those who have probed the deeper horizons that gas is extremely plentiful there.

At shallow levels gas in commercial quantities can only be found where there is an exceptionally good caprock. This is true whatever the origin of the gas may be. At the deeper levels the rock tends to be compressed by the weight of the overburden, and this causes underlying gas-filled regions to be sealed off without the requirement of a particularly impervious material. The underlying gas is then at a pressure at which the pores or fractures in the rock can be held open. If the gases generally come from below then this deep domain is likely to be frequently filled with gas and the amounts that could be expected in the depth interval from 15,000 to 30,000 feet in the United States may then be hundreds of times more than had previously been estimated.

There has been much more deep drilling in the United States than elsewhere in the world. Indeed hundreds of gas wells have been drilled in this country to depths of 15,000 feet or deeper and a good many are producing. U.S. drillers are the undoubted world leaders in this technology. Their skill and experience could help greatly to explore the deeper levels in Europe or in Japan where the finding of large quantities of deep gas would have the greatest impact.

Despite the leading position of the U.S. in this field it is still only a very small fraction of the potentially gas bearing rocks in the U.S. that have been explored by the drill. It has been estimated that 97% of possible gas reservoirs remain to be investigated.

Much could be done to improve the scientific and technical base on which prospecting techniques have to rely, and a program of research and development in this area would be of the greatest benefit. In the preparation for shallow drilling very sophisticated investigations might not have been economically viable. The high cost of deep drilling should produce quite a different outlook there. Seismic exploration has been greatly improved and is in full use. Other possible exploration techniques are still largely neglected, but could make a very substantial difference in defining more closely the areas in which the large investment of deep drilling is worthwhile.

Several surface chemical associations with deep gas reservoirs have been noted, such as the presence of particular trace elements above gas fields as well as the presence of unusual carbonates in the surface soil. In many cases the relationship of these surface characteristics to the underlying deposits could not be doubted, but nevertheless with too little understanding of the reasons for these relationships, the techniques were not trusted sufficiently to find a wide application for prospecting. On the basis of the outgassing theory which I have outlined, it becomes clear that most gas bearing regions have been greatly oversupplied, and that the amounts caught in the traps are very small compared with the amounts that have leaked out. Chemical prospecting can find the termination of the leakage paths on the surface and therefore give a set of new clues as to the position of the traps. Surveys of a range of trace elements over known gas deposits should be carried out on a large scale so as to learn more of the associations to be expected. Scientific tools for trace element analysis in the field should be devised, so as to make rapid surveys of big areas of land a practical possibility. Modern methods of chemistry are extremely powerful, and have not yet been applied to a search in the field. The cost of finding deep gas could be greatly reduced by the introduction of such techniques, and this would of course show in the ultimate price at which the deep gas could be produced.

The Los Alamos Scientific Laboratory would be very well placed to undertake such work. It has superb facilities that are very well suited to such tasks as trace element analysis, and of course the region would be ideal for experimentation in the field. It would be worth while to have a major program in this area, considering the economic importance of it. The laboratory could have a great impact on the entire field of prospecting for hydrocarbons.

But even with a great improvement in the methods of prospecting, a vigorous deep drilling program will still be required to discover the large reserves of deep gas. Also here a federal program can be of help; but it is most important that the industry should have the incentive and the financial resources to enter into a large deep-drilling program. This brings me to the problems of policy and of economics. The high cost of deep drilling means that no cheap gas can be produced from the deep levels. It can however, be produced at a price that is competitive with that of imported oil for many applications. A drilling program can be sustained only if an expanding market at an adequate price level can be assured. Without such a drilling program, the large reserves of deep gas may be suspected but they cannot be discovered. Drilling is still the only way of making the discoveries and the large capital resources necessary for this will not become available unless there is a reasonable assurance of such a market.

If the deep drilling industry can expand, it seems not unreasonable to expect that the real cost of production of deep gas could be brought down substantially through improvements in tools, materials and techniques. A reduction of deep drilling costs to half of what they are now would seem possible within three or four years. An important line of development work for deep drilling is in progress at the Sandia Corporation in New Mexico.

The curb on the expansion of the gas market stems from the belief that the gas resources are small and in turn, the large resources which we believe to be there, cannot be discovered except when a greatly expanded market is available. Before the discovery of deep gas and the realization that it is a very large resource, it was thought that the domestic gas supply would soon dwindle and therefore it seemed prudent to limit the market. New industrial use was prevented by the Fuel Use Act, as was the use of gas in electric power generation. This prevented the expansion of the market, and meant that the remaining shallow gas, that could be produced much more cheaply, could satisfy this limited market almost completely for the present.

Due to the limitation of the market, exploratory drilling to the deep levels was much more limited than it could otherwise have been, and therefore the rate of certified new discoveries was regarded as disappointing. A low rate of new discoveries was taken by some to mean that the restrictions on the use of gas should be retained. This policy leads to a downward spiral and to a continued dependence on imported oil, even if gigantic resources of deep gas exist in the country, that could be produced at a price competitive with the imported oil. The prediction of a shortage leads to regulations that create a real shortage. Similarly the understanding that there is a large resource base should lead to a regulatory policy that allows this resource to be opened up. Most Americans would prefer to see the money spent here to find and produce domestic gas than to spend it abroad for the continued importation of oil. A vigorous pursuit of this resource should lead to complete energy sufficiency in just a few years.

Energy independence is obviously desirable from many points of view, and in the economic picture one may wish to include the large savings in military expenditures that would then be possible. It could be argued that even at a somewhat higher cost than that of the continued importation of oil, it would be worth it. This has indeed been the outlook which was responsible for the Synfuel programs, which we consider would be far less productive for the same investment and far more damaging to the environment than a rapid exploration and exploitation of the deep gas resources.

A program to create energy self-sufficiency in a few years, based on the deep gas resources, would have to allow the deep gas to replace imported oil in all applications where it can be competitive. A changeover from oil to gas in most stationary applications can be achieved quickly and at modest cost. The problem of sulfur and other effluents is greatly diminished, and gas-burning on an industrial scale can comply with stringent clean air regulations. One can see many advantages and no disadvantages in allowing the deep gas resource to be opened up by giving it the free market in competition with imported oil.

If, however, the market remains constricted and the deep gas has to compete for this limited market with the remaining shallow gas which is much cheaper to produce, then for the present further deep exploration would be stopped. The supplies of shallow gas will indeed dwindle in the course of a very few years, and a new fuel crisis, high fuel prices and an increased dependence on foreign oil would be the consequence. It is true that there would then be an incentive to drill the deeper levels again, but a number of years will have been lost and the consequences of an increased dependence on imported oil will have been felt.

From the environmental point of view a move from all other fuels to gas is very desirable. The content of sulfur and of other damaging substances in the effluent can be kept very much lower without incurring economically unacceptable costs. Drilling for gas produces a minimal disturbance to the landscape, incomparably less than mining coal or any of the attempts to extract energy from oil shales or tar sands. Deaths from accidents or disease are at a far lower level for gas drilling than for any mining operation.

It is not certain yet that the build-up of atmospheric carbon dioxide is creating a problem, but one should be prudent. The burning of natural gas produces only about half as much carbon dioxide for the same energy released as the burning of coal, and also substantially less than the burning of oil. There is a clear case that gas is the most desirable of all fuels and that therefore the greatest effort should be made to expand its use as rapidly as possible.

Further in the future, but probably still several decades away will come the time that horizons well below 30000 feet will need to be tapped. By then it is probable that new materials and new drilling techniques will be available, and so, for a long time, the energy resource of deep gas will be able to keep up with the demand. As we have said, the atmospheric carbon dioxide burden will be minimized by reliance on gas compared with the combustion of any other fuel, but if the carbon dioxide poses a real problem nevertheless, one could go one step further. If methane becomes really plentiful, then one could afford to burn only the hydrogen component and leave the carbon, or perhaps find large scale industrial applications for it. In that case one would derive approximately half the energy but with the production of virtually only water vapor and no harmful effluents.

To sum up, it is my belief that we have a gigantic resource of natural gas in levels that are deep but accessible by present day techniques. It is of the utmost importance to make our country energy independent, and this resource is the quickest, most practical and least disturbing way of doing it. Regulatory policy must therefore be so shaped as to maximize the speed of development of this resource, and this will happen if every energy user is given the straightforward choice between buying deep gas or imported oil. Price regulations and market limitations of the past have created a difficult situation at the moment and it will be necessary to assure a substantial expansion of the market for gas before a competition between shallow and deep gas should be allowed to occur; otherwise the deep gas would be temporarily at such a disadvantage that the development of the deep gas resource would be arrested. A real crisis would then develop in a few years when the shallow gas does run out. It would also mean a further delay before we can demonstrate that we can achieve energy independence, and surely such a demonstration is most desirable and urgent.

A major program to improve the science and technology of exploration for deep gas is desirable. Improvements in the technology of deep drilling are also a major concern, and should be considered of national importance, since these would shorten the time for the U.S. to achieve energy independence.